

Industrial Scale High Precision 3D Printing for Healthcare Products

WINNER
BIT
BEST OF
INDUSTRY
AWARD



High Throughput and Scalable 3D Printing with highest precision
Nano – Micro - Macro

Best of Industry Award Winner 2018

Additive
Manufacturing



June 7, 2018

Best of Industry Award Winner 2018



Application Engineer

CTO

CEO & Managing Director

Director of Sales

Photonics
~ 300,000 employees in EU
4 female C level
(Source: EPIC)

June 7, 2018

We are ...



Fraunhofer Spin-Off in 2013

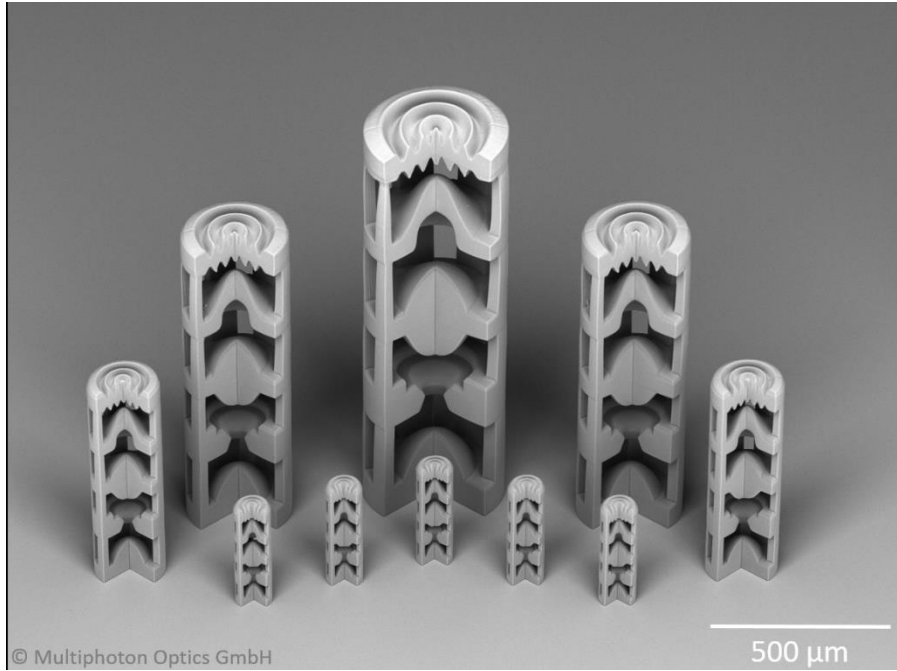
Seed Round in Oct. 2014, Round A in Oct. 2015

Worldwide B2B Bluechip Customers

Products High Precision 3D Printer LithoProf3D®*
Prototyping & Engineering



We stand for ...



Diameter (μm)	Height (μm)	Fabrication time (min.)
100	317	5
200	615	20
300	900	50
400	1166	100

Scalability in photonics & medical packaging

- High Throughput
- nm Scale Precision
- Large Area

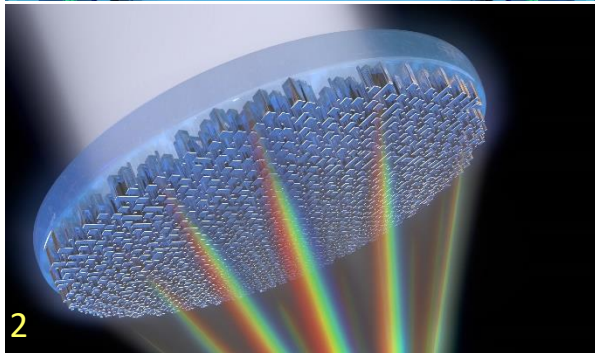
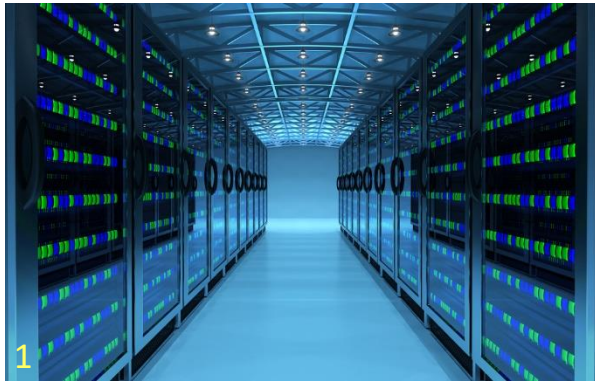
Lean processes

Reduced Cost

Integration in Standard Workflows

Green Technology

Markets



1 Data center image: <http://www.bmwblog.com/2017/06/23/bmw-building-giant-new-data-center/>

2 Metalens image credit: Jared Sisler/Harvard SEAS

3 Imaging chips: Sirona Dental Systems GmbH

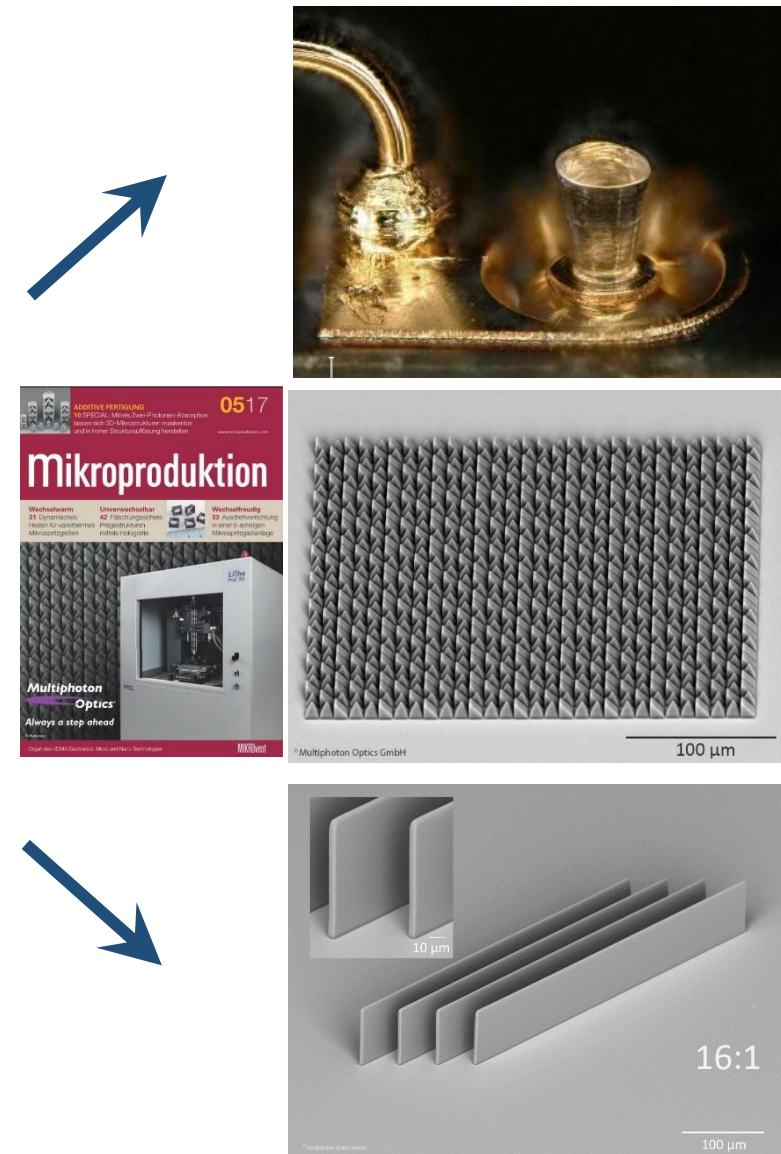
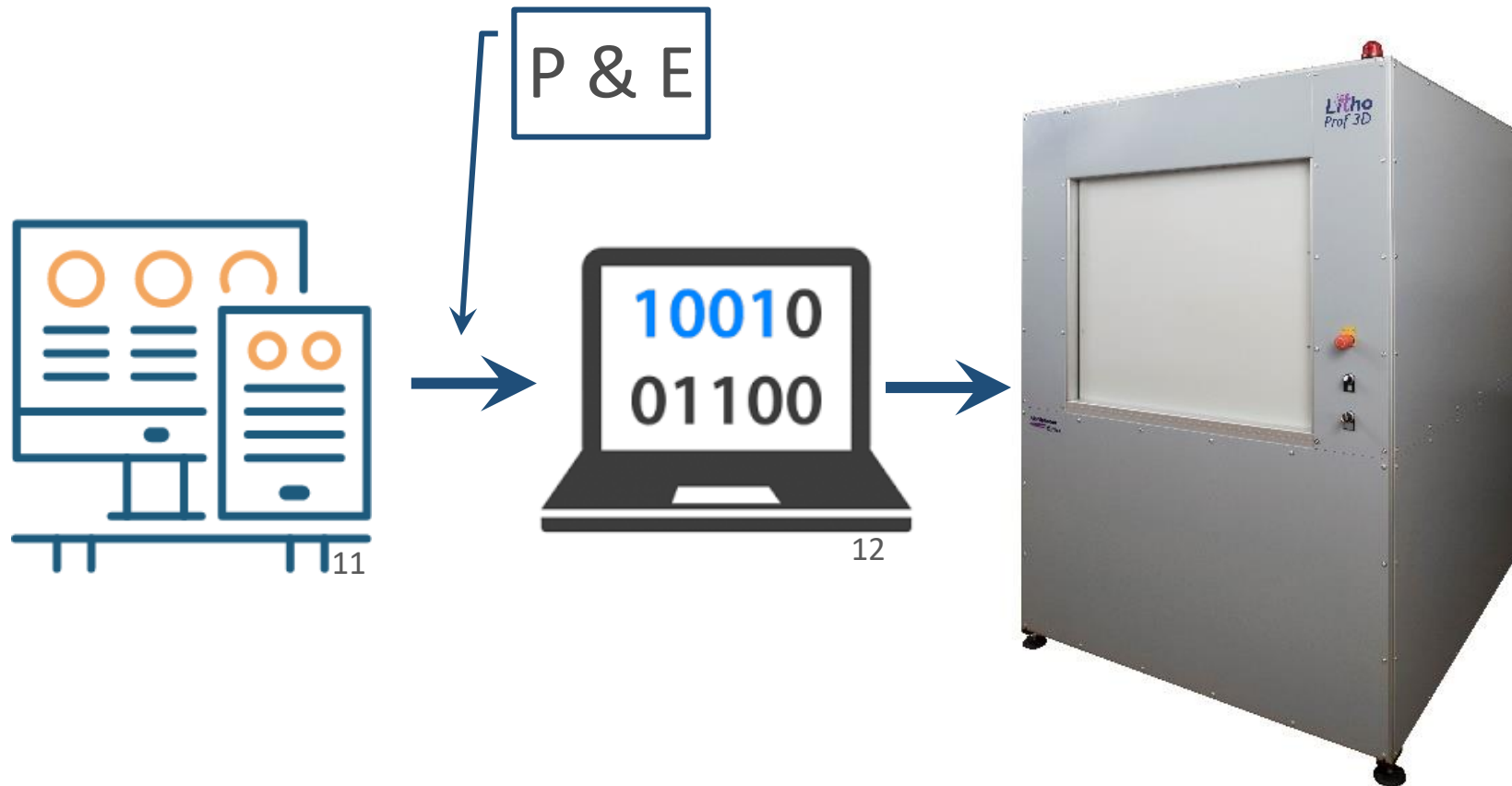
www.multiphoton.de

4 – 6 osram-os.com

7 Apple's iPhone

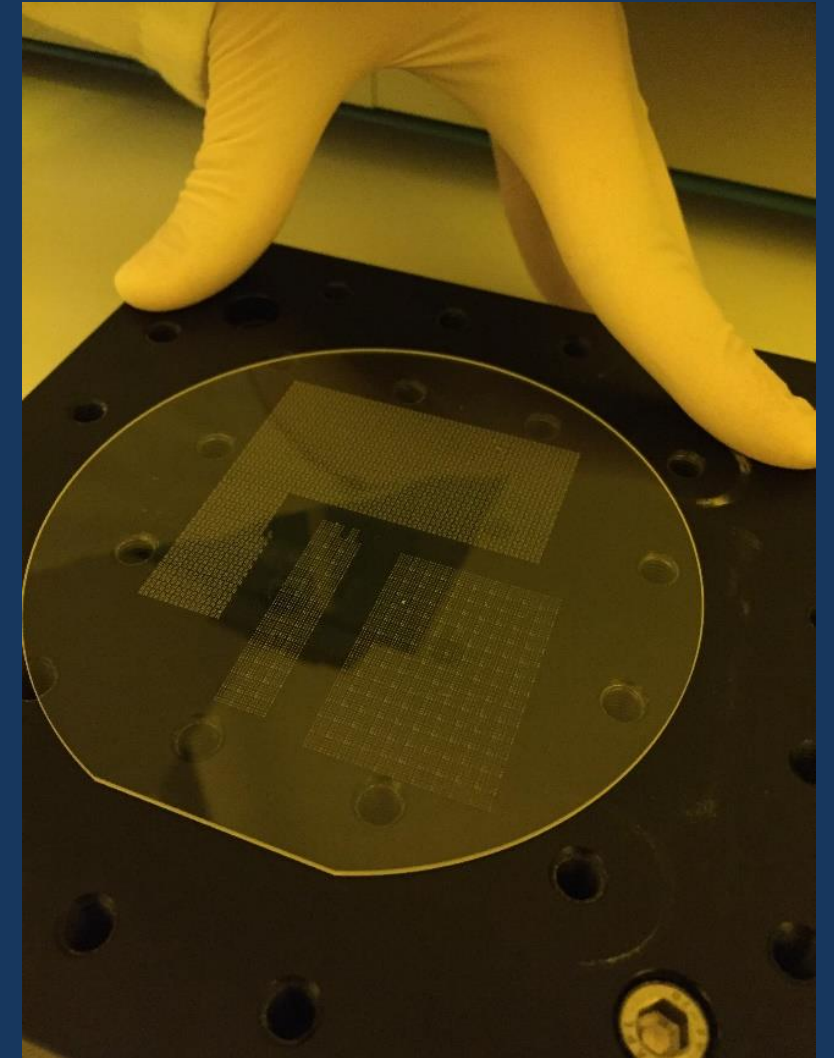
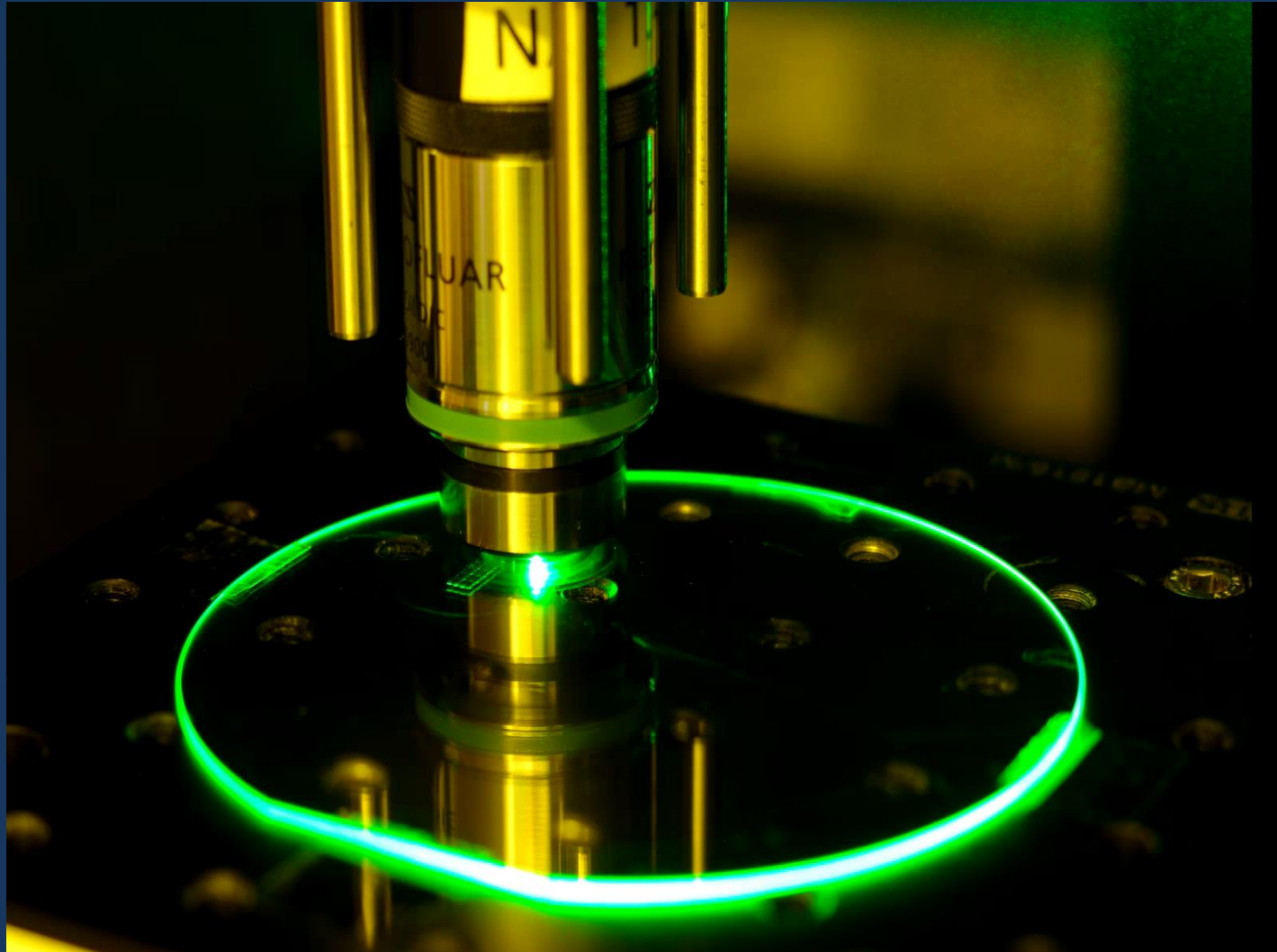
8 Microsoft's MR HoloLens

Industry 4.0 Manufacturing Workflow



Your gateway to a fully digitized value chain.

Worldwide 1st Demonstration of Wafer-Scale HP-3DP



Drug Delivery Structures

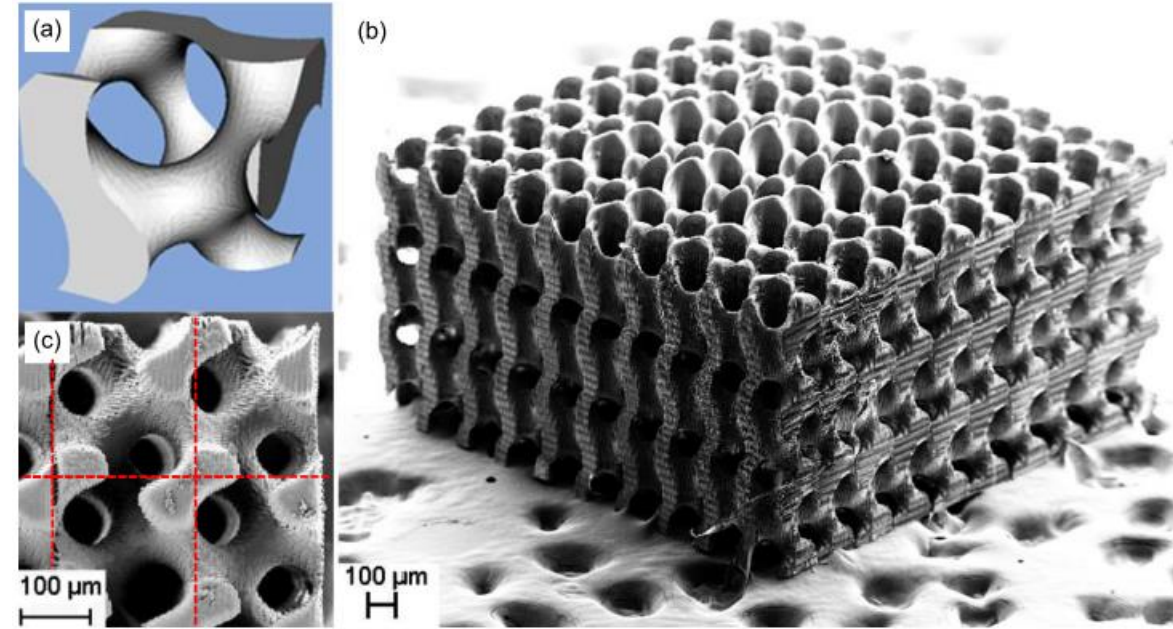
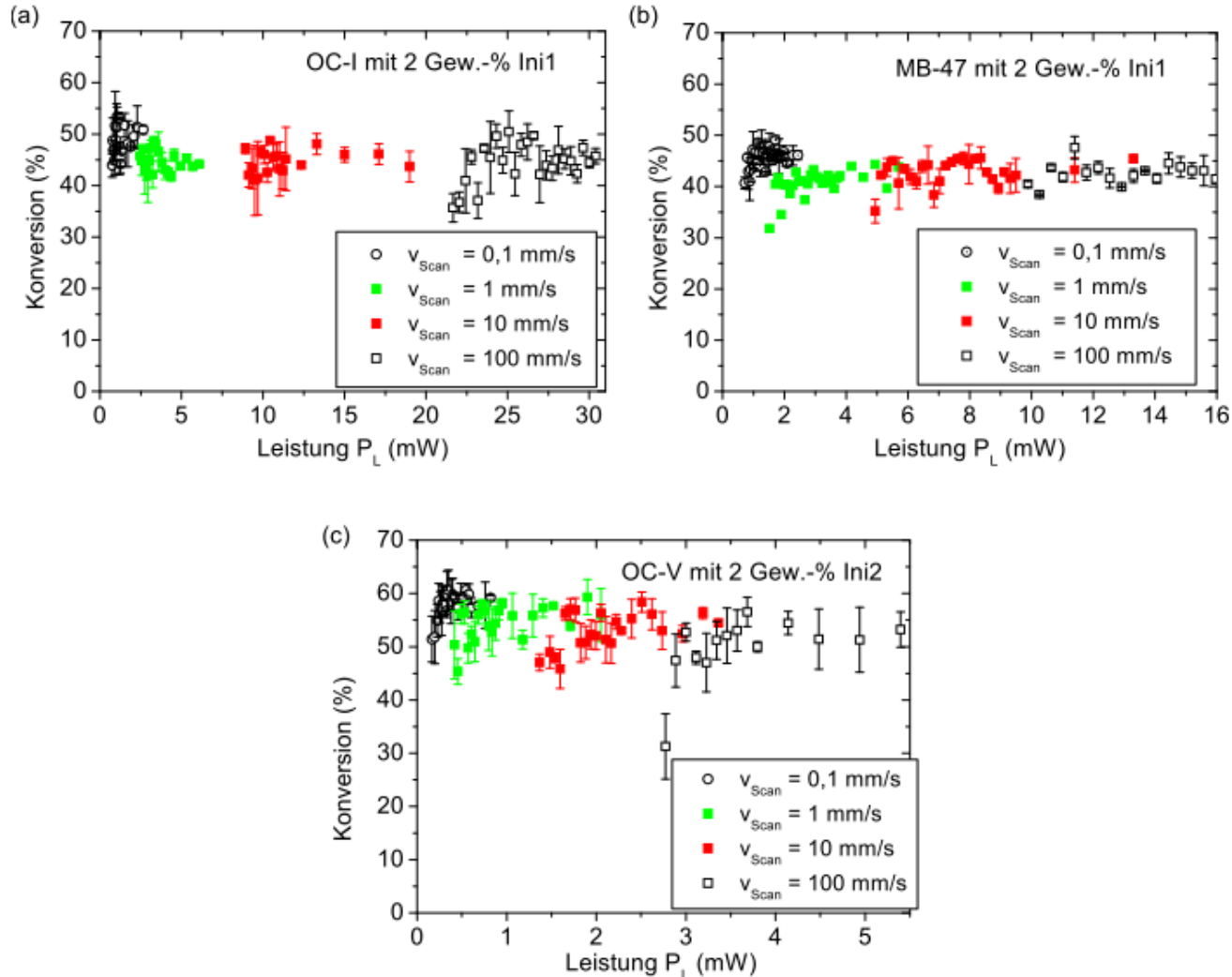
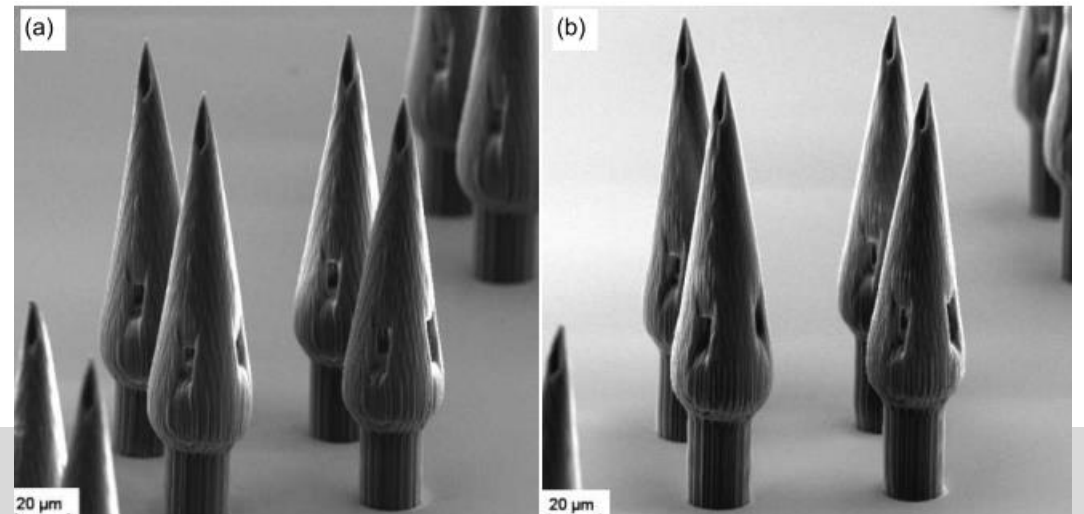


Abbildung 5.3.23: (a) CAD-Design der Gyroid-Einheitszelle, (b) REM-Aufnahmen der gesamten Gyroid-Struktur und (c) Detail-REM-Aufnahme von vier simultan hergestellten Einheitszellen.

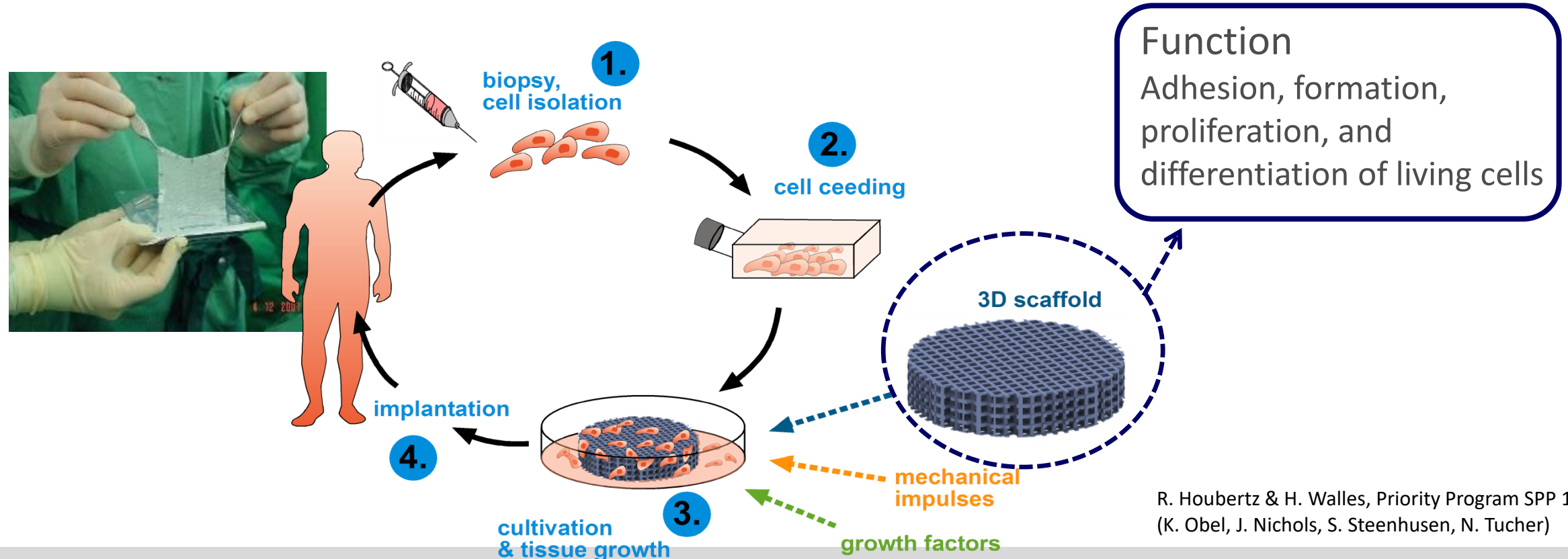


Parallelization (2008 - 2010)

R, Houbertz, Th. Stichel,
Fraunhofer Challenge.

Create complex 3D scaffolds w. pore sizes up to 200 μm for human cells to repair or replace portions of or whole tissues (ex.: bone cartilage, blood vessels, skin, muscle, bladder)

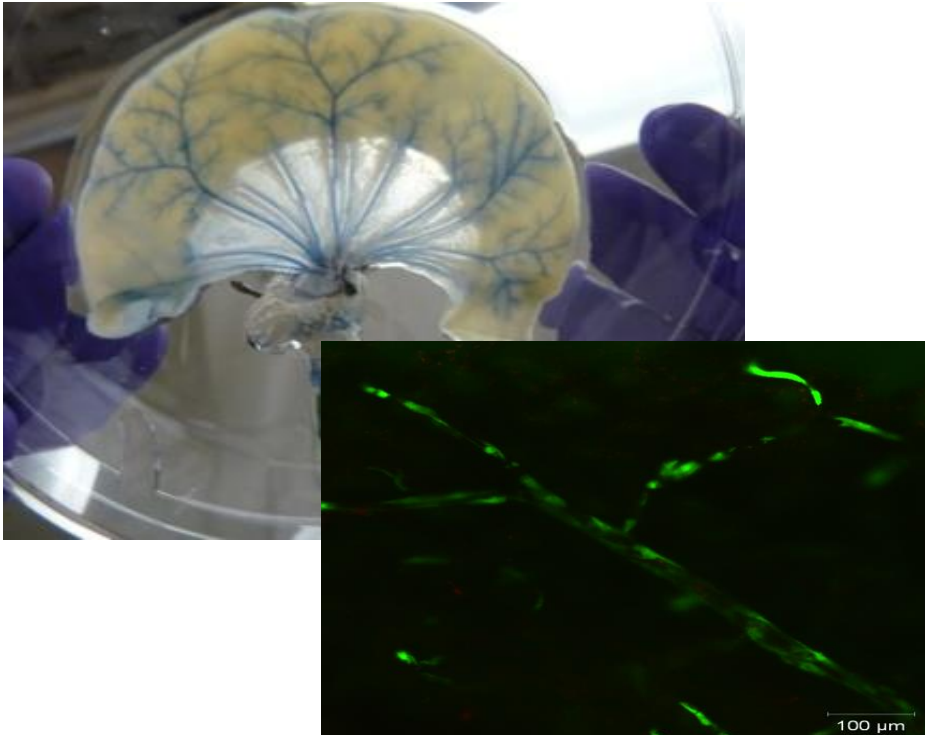
→ Demand of **vascularized scaffolds** for supply of nutrition and oxygen and removal of metabolism products (in nature: blood vessels)



R. Houbertz & H. Walles, Priority Program SPP 1327
(K. Obel, J. Nichols, S. Steenhusen, N. Tucher)

Creation of an extracellular matrix ECM (e.g., from pork's small intestine - jejunum)

→ Biological vascularized scaffold (BioVaSc) for seeding with human cells



Advantages

Structures for re-seeding with human cells are maintained

Functional tissue can be created. The structural features resemble the natural role model

Biocompatible matrix

Disadvantages

Complex production

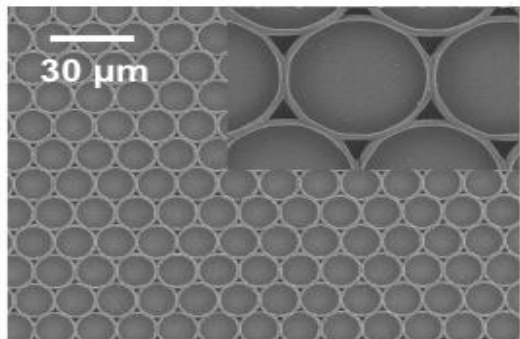
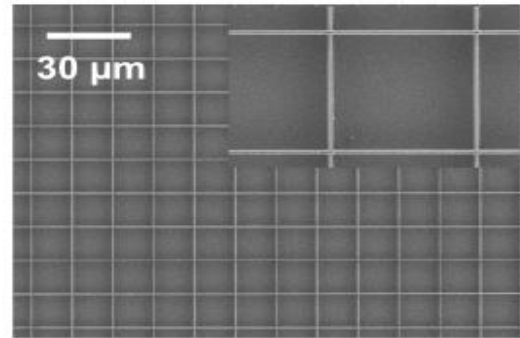
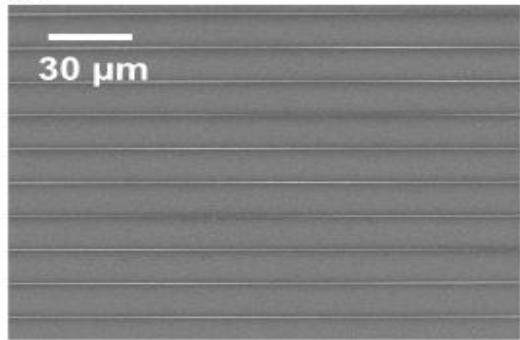
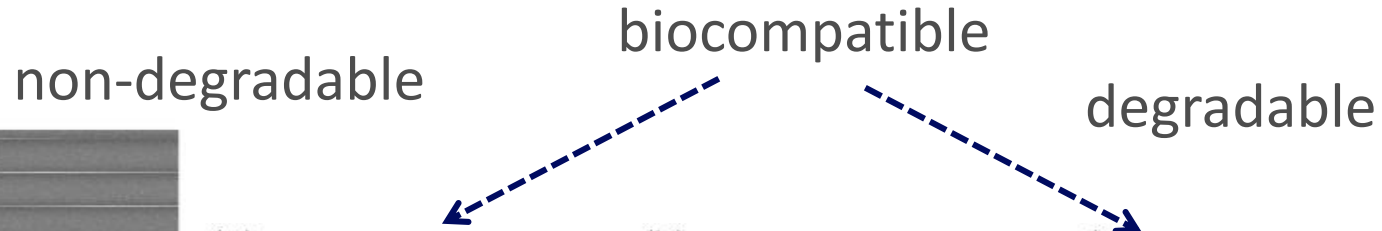
Potential pathogenic organisms

Parts of the matrix (collagen 1 and 3) are not human

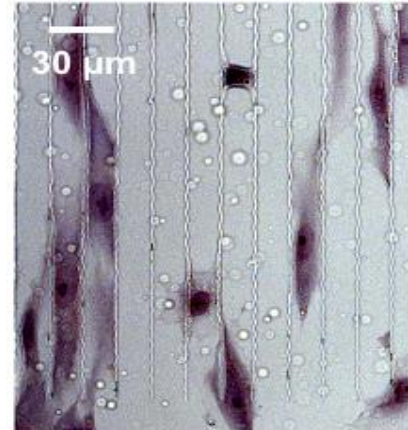
→ risk of immunogenicity

Alternative fabrication methods
and materials

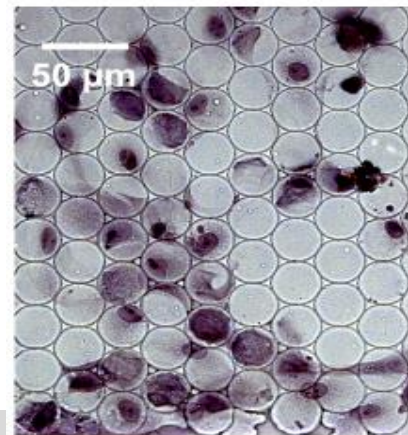
Surfaces and Scaffolds



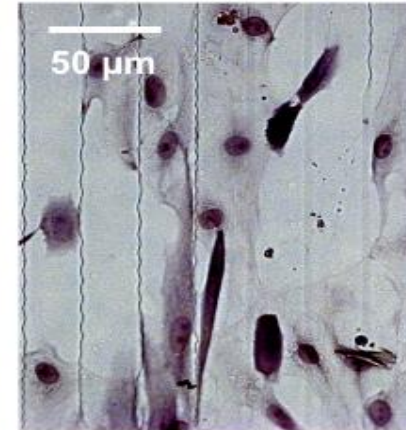
(a)



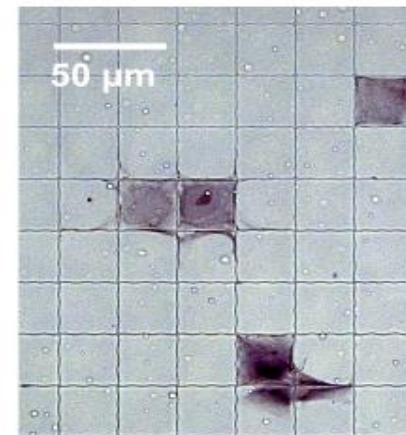
(c)



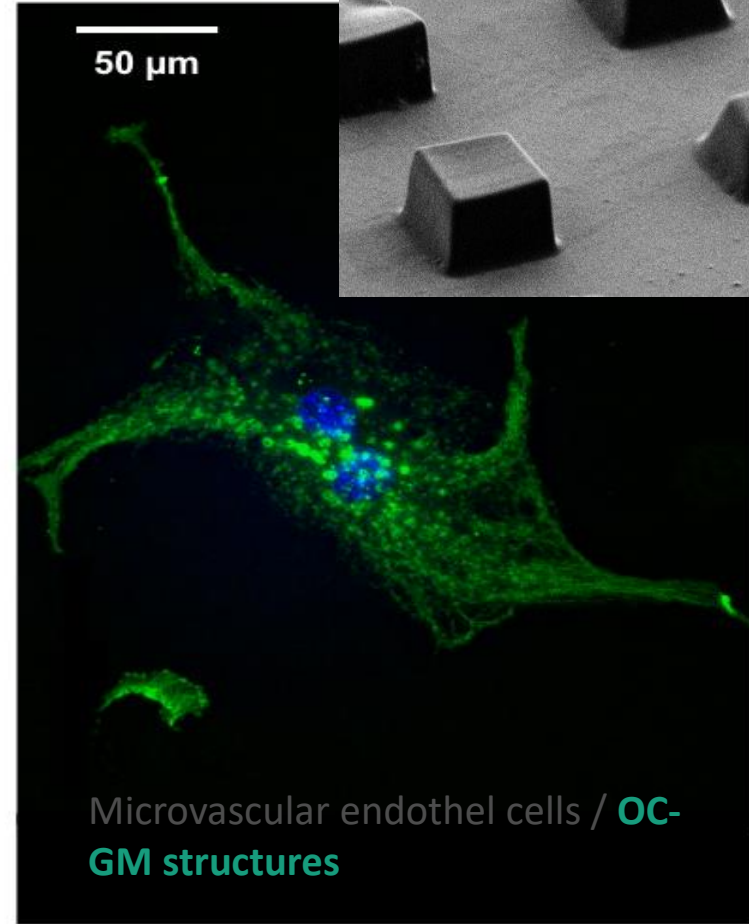
(b)



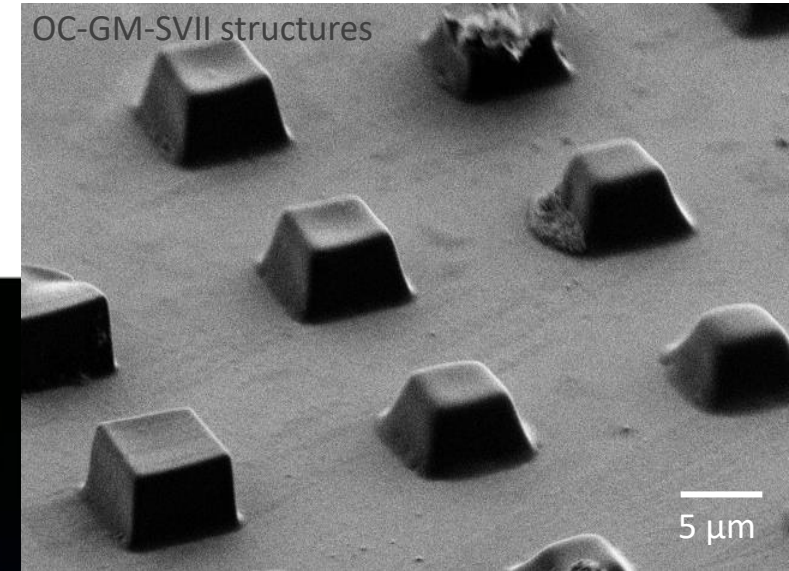
(d)



(e)

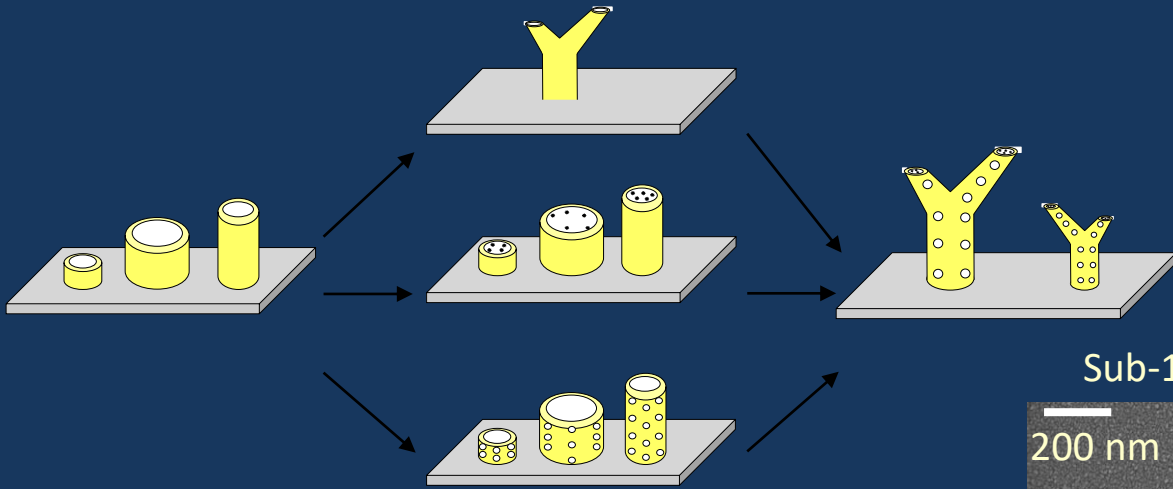


Microvascular endothel cells / OC-GM structures

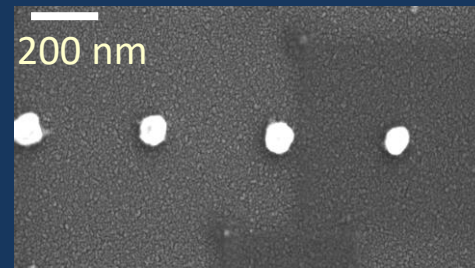


R. Houbertz & Heike
Walles SPP 1327
(K. Obel, J. Nichols,
S. Steenhusen, N. Tucher)

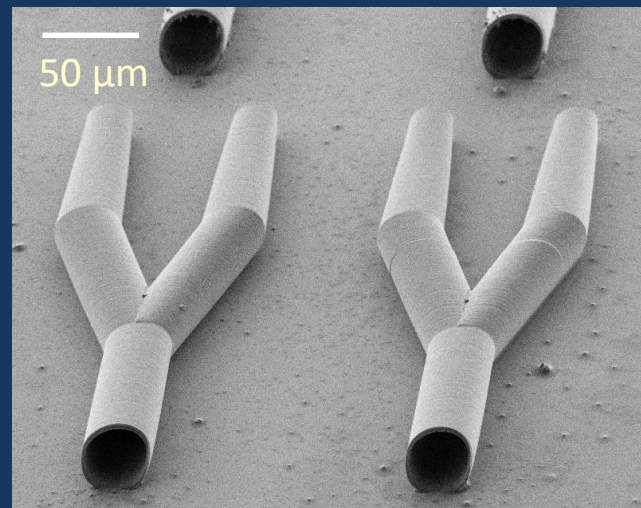
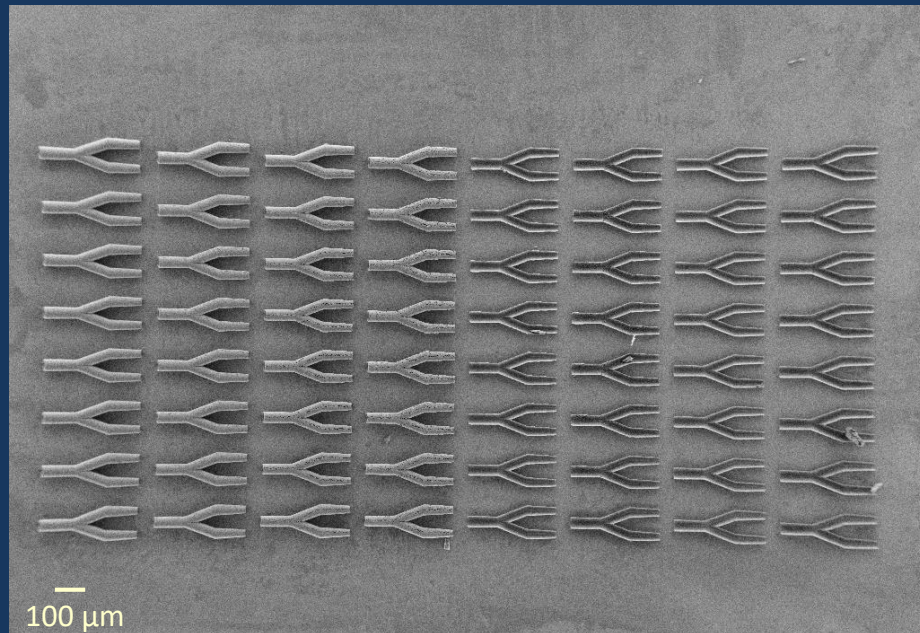
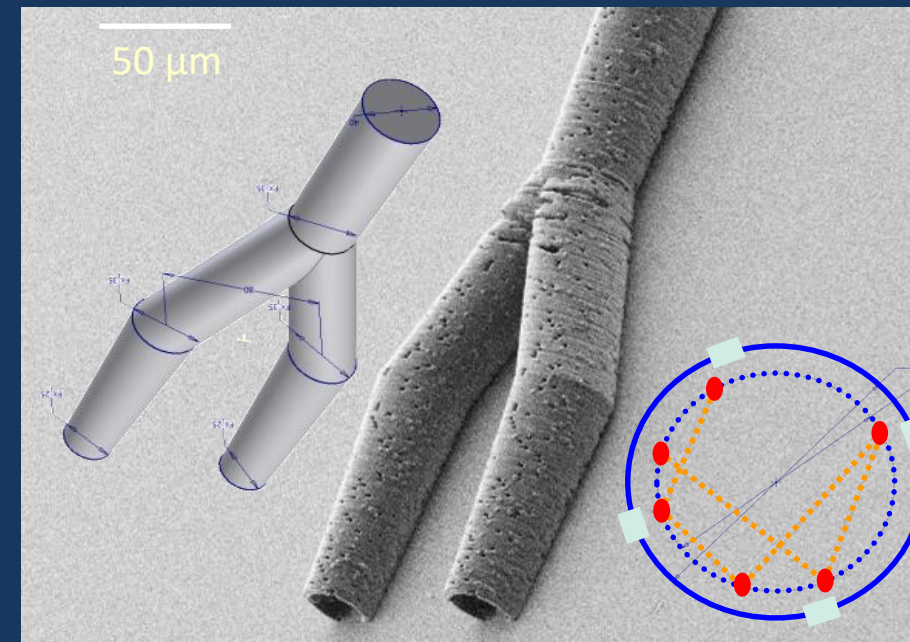
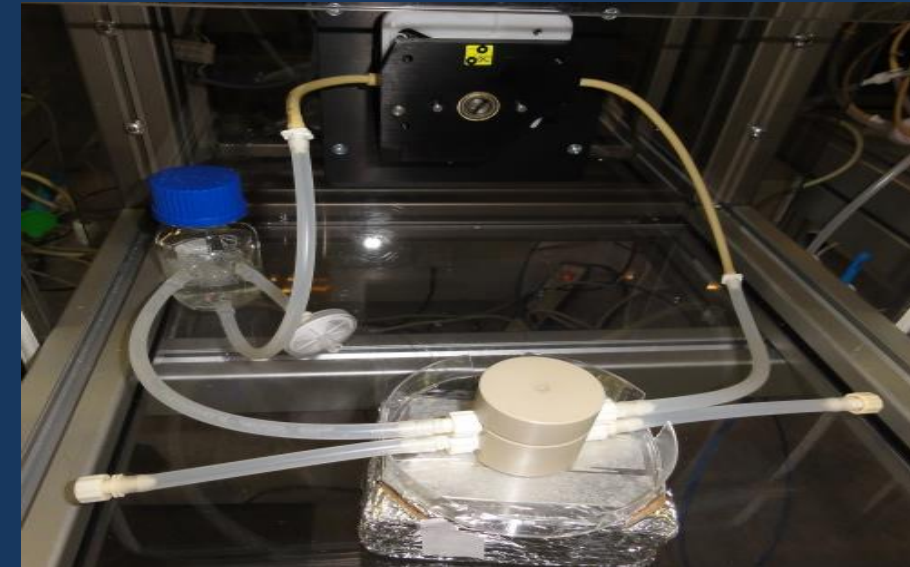
Getting Ready for Vascularized Scaffolds

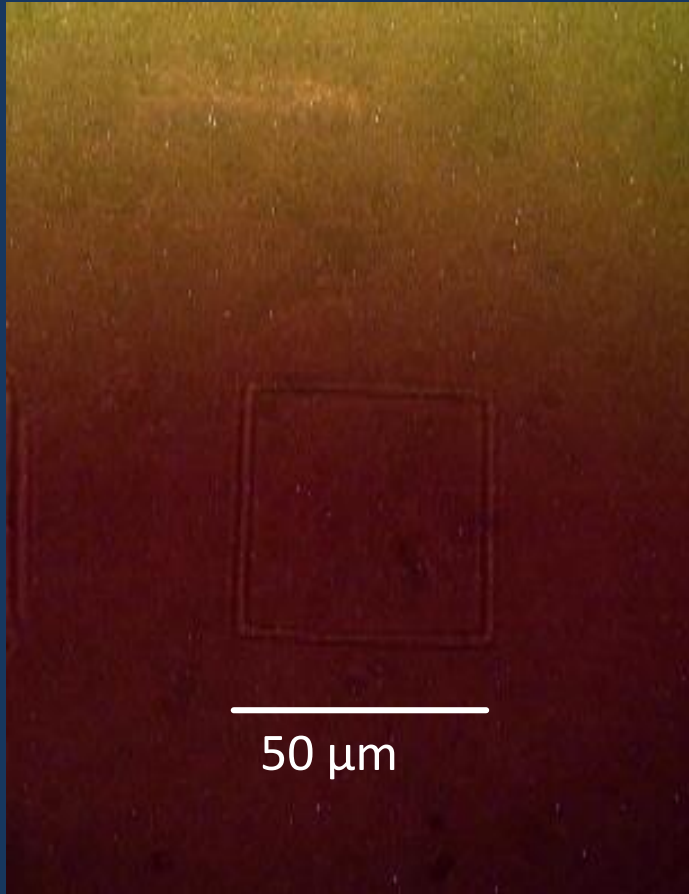


Sub-100 nm voxels

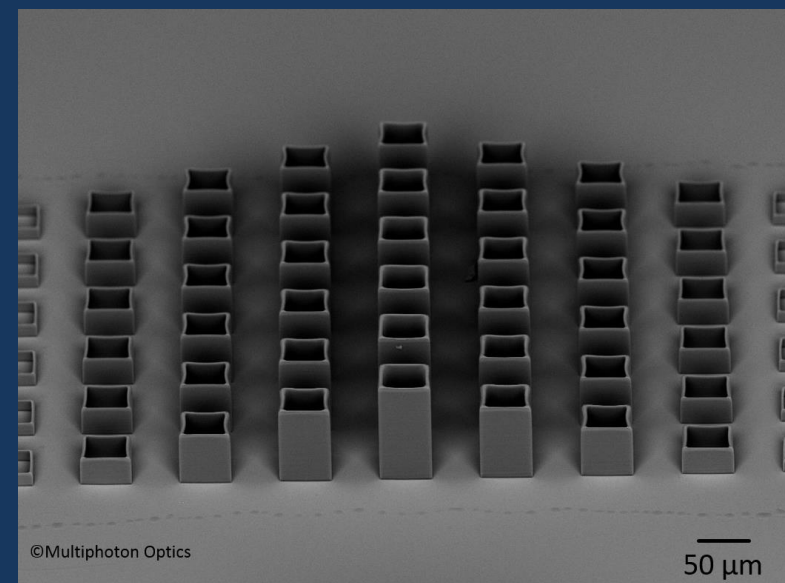
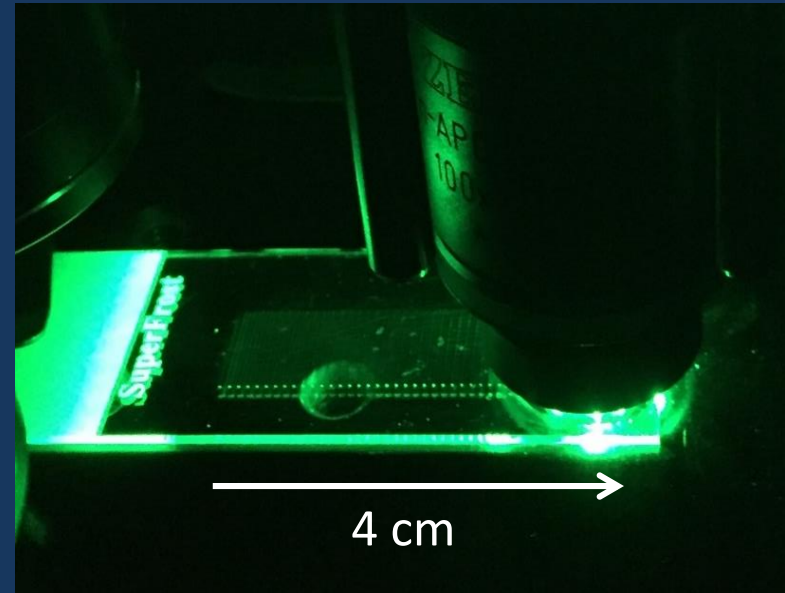


S. Steenhusen, R. Houbertz (2012)

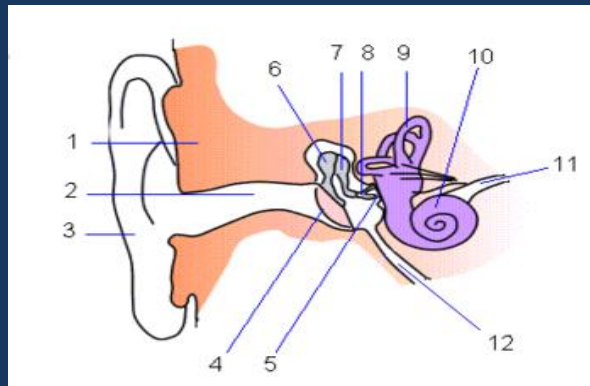
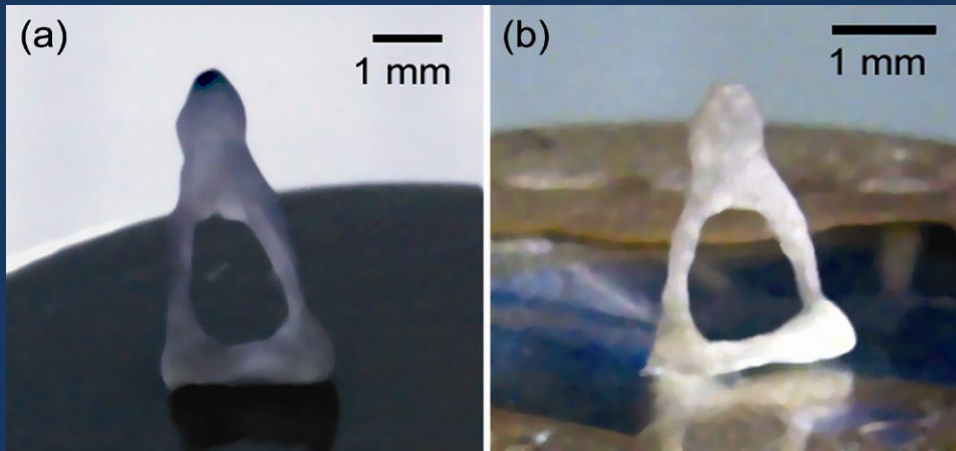




Microreactor

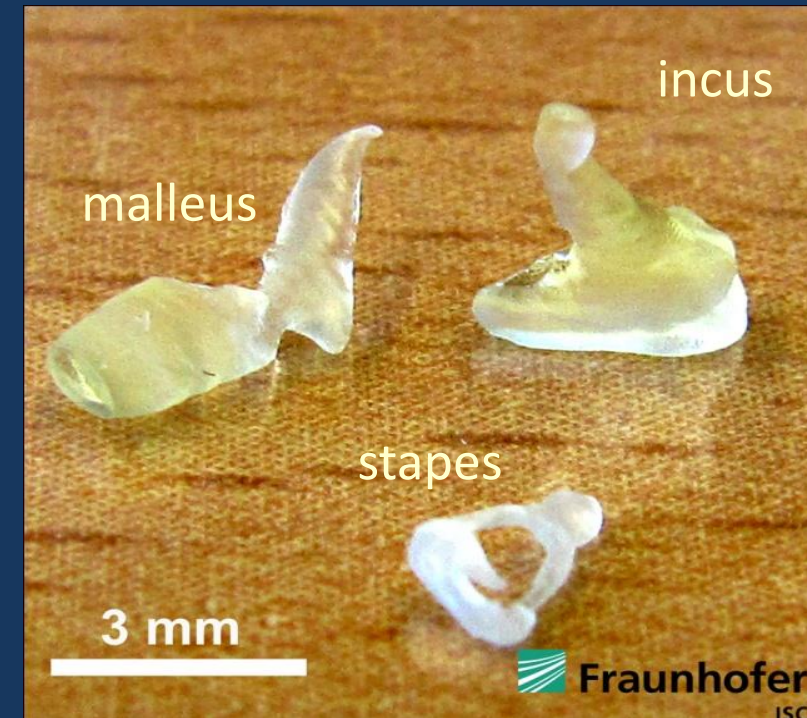


Defocussing correction and power adaptation



T. Stichel et al., J. Laser Micro/Nanoengineering 5, 209 (2010)
T. Stichel, B. Hecht, R. Houbertz, G. Sextl, Opt. Lett. (2015)

Human ossicles in original size

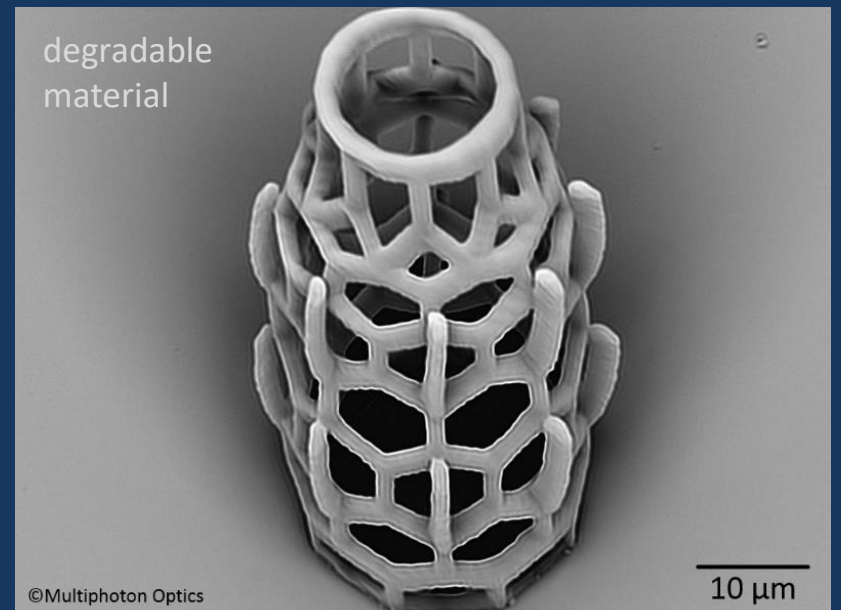
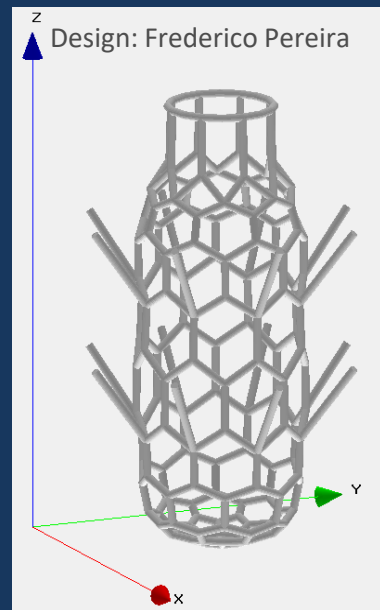
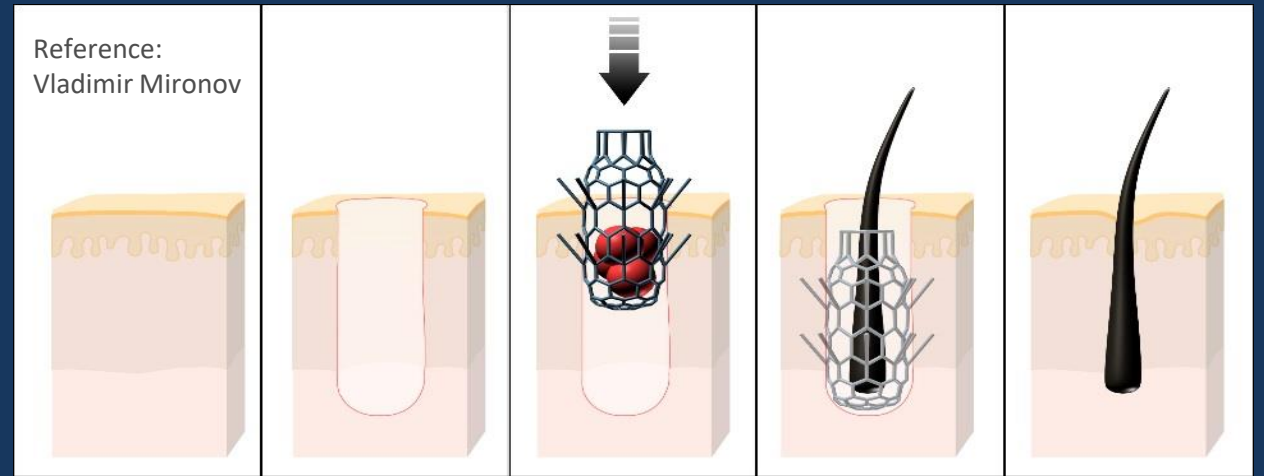


R. Houbertz, S. Steenhusen, Th. Stichel, G. Sextl,
Coherence and Ultrashort Pulse Laser Emission,
F. J. Duarte (Ed.), ISBN: 978-953-307-242-5,
InTech (2010)

Automation Capillinser

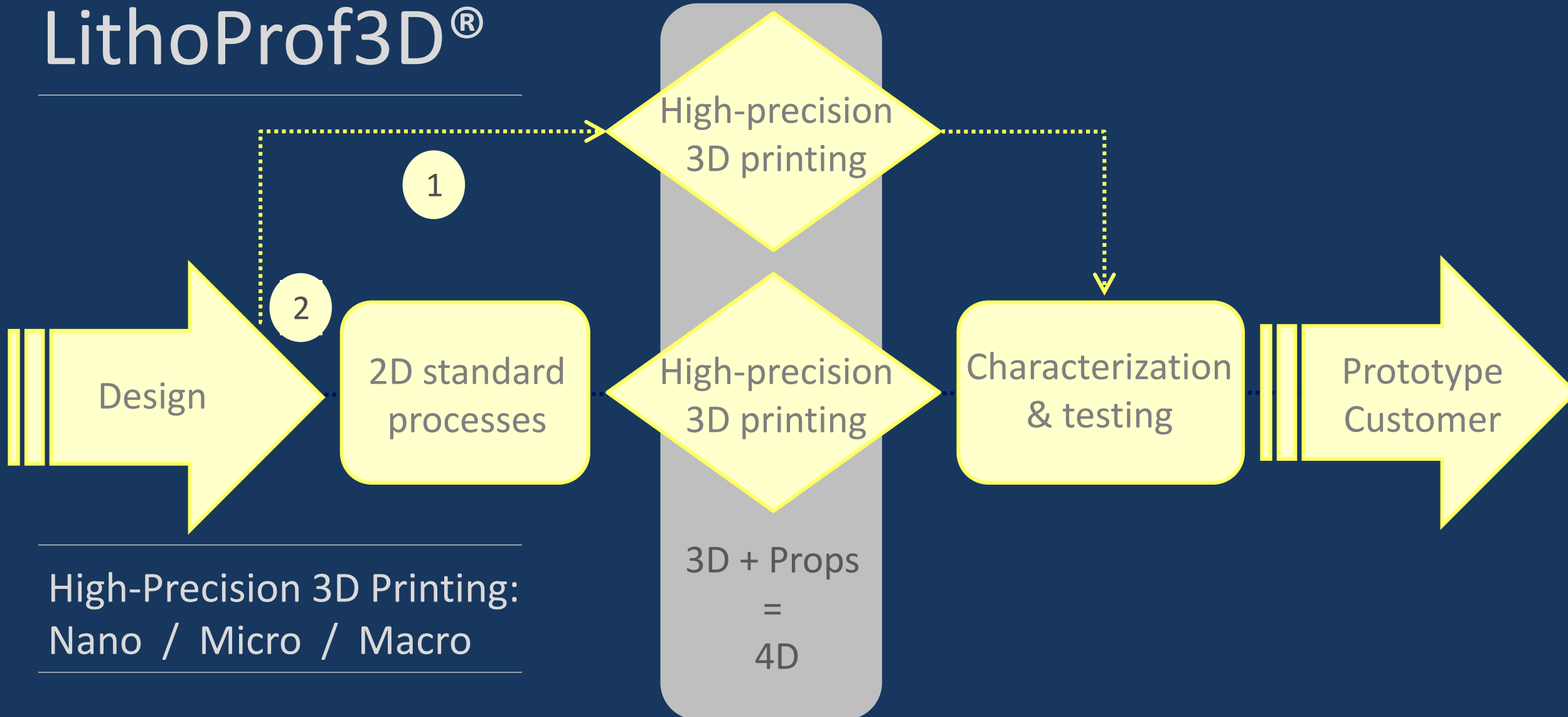


<https://www.express.de/koeln/kloppts-schoenheits-chirurg-operiert--held-burkan--neue-haare-fuer-12-000-euro-22574752>



<http://www.mcombs-wall.com/wp-content/uploads/2013/03/Pick-and-PLace-Robotics-Page.jpg>

LithoProf3D[®]



High-Precision 3D Printing:
Nano / Micro / Macro

Just 4 Fun Demonstrations of Workflow Integration

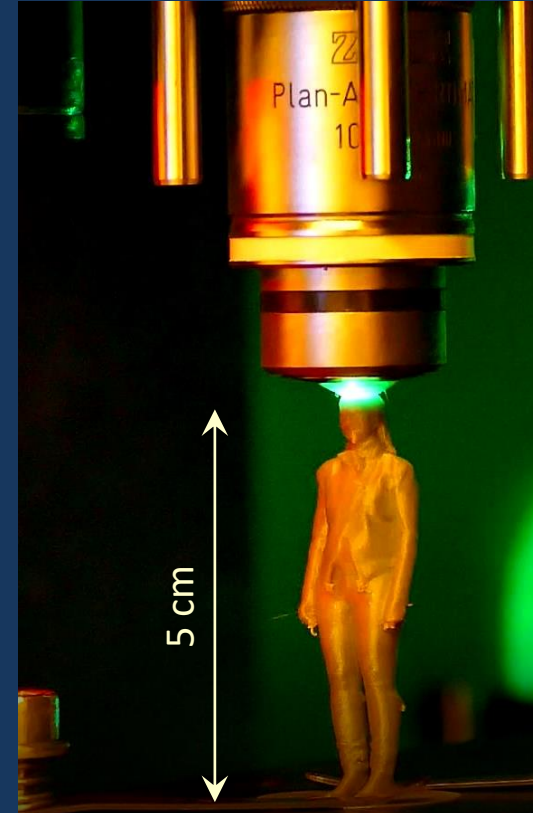
Scanning



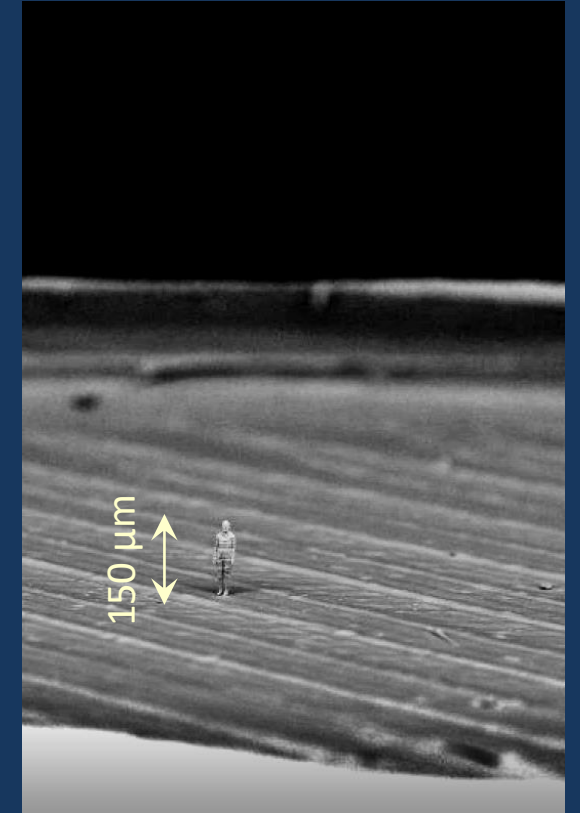
FDM



HP3DP

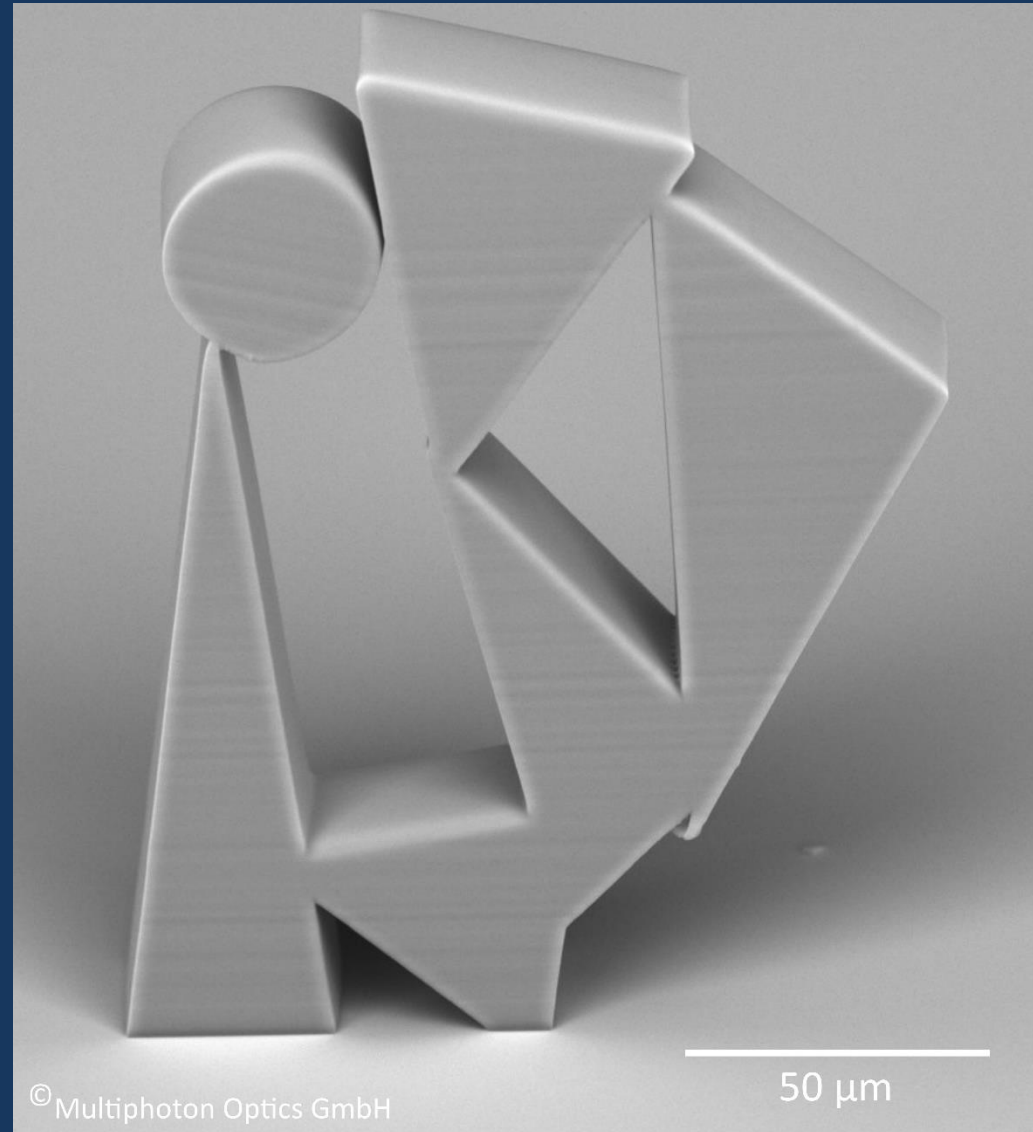
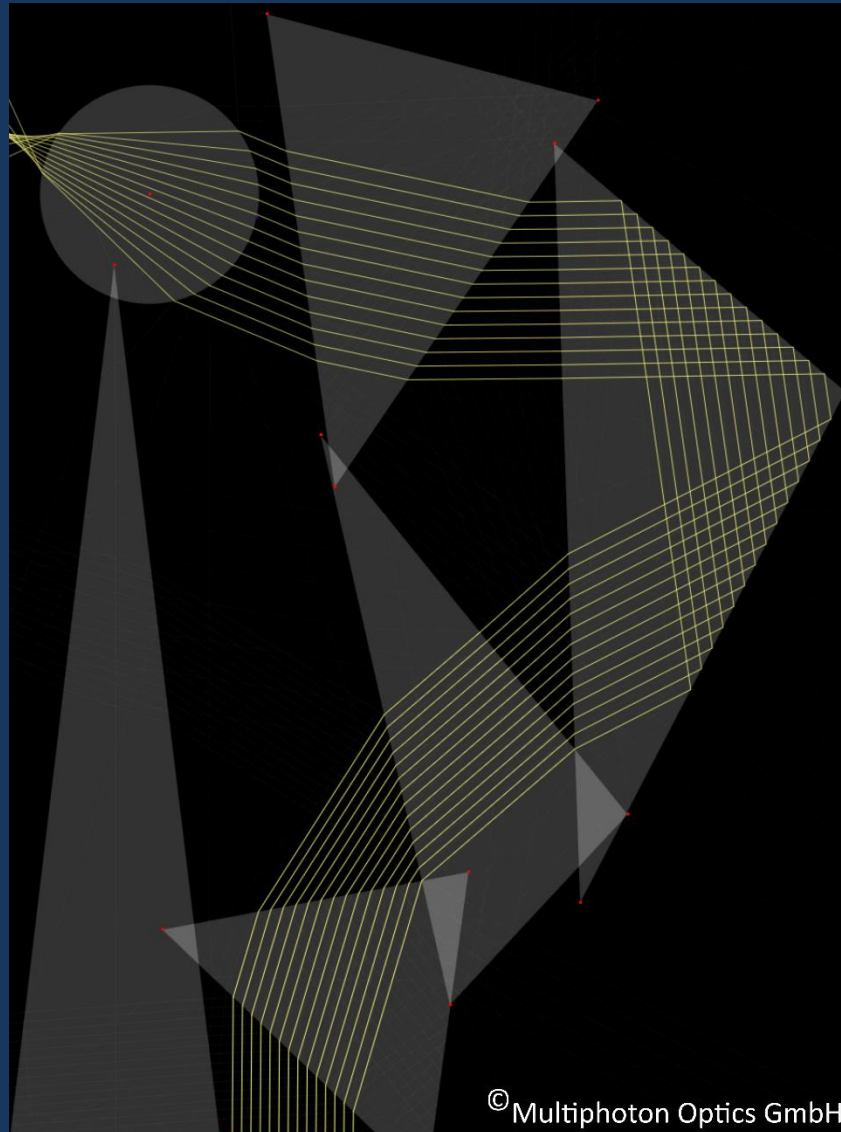


Analysis



<https://youtu.be/Qmu4CvQFypc> (FDM/TPA)

<https://youtu.be/5NwEpWBl0oo> (SLA/TPA)



Engage via ...



Friedrich-Bergius-Ring 15, Wuerzburg, Germany

Phone +49 931 2999 5890

multiphoton.de

info@multiphoton.de



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